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HABITAT DIFFERENCES IN FEEDING HABITS AND BODY SIZE OF THE PREDATORY STINKBUG *PERILLUS CIRCUMCINCTUS* (HEMIPTERA: PENTATOMIDAE)

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Abstract.—Near Ithaca, New York, *Perillus circumcinctus* reproduces in stands of *Bidens cernua* and *Solidago* spp. (Compositae) in early summer. Nymphs of this predator consume larvae and adults of the beetle *Calligrapha californica coreopsivora* (Chrysomelidae) in stands of *B. cernua,* and primarily larvae of *Trirhabda* spp. (Chrysomelidae) in stands of *Solidago*. Newly molted adults of *P. circumcinctus* in stands of *Solidago* are larger than newly molted adults of *P. circumcinctus* in stands of *B. cernua*. It is suggested that differences in the physical structure of the two habitats result in nymphs of *P. circumcinctus* experiencing more difficulty in harvesting prey in stands of *B. cernua*. Increased difficulty in harvesting prey results in smaller adult sizes.

Introduction

The predatory stinkbug *Perillus circumcinctus* Stal (Hemiptera: Pentatomidae) is a specialized predator of beetles of the family Chrysomelidae (Hart and Gleason 1907; Vestal 1913; Knight 1923; Parshley 1923). In the Ithaca, New York, area this univoltine predator usually oviposits in stands of goldenrod (*Solidago* spp.) and reproduction is timed so that nymphs mature by feeding almost entirely on beetle larvae of the genus *Trirhabda* (Chrysomelidae) (Evans 1982a). While studying the habits of *P. circumcinctus* near Ithaca, I found this species in only one additional habitat, stands of *Bidens cernua* (Compositae). A comparison of the seasonal patterns, feeding habits, and adult body sizes of *P. circumcinctus* in *B. cernua* and *Solidago* provides a perspective on the ability of this predator to exploit chrysomelid beetles as prey.

Observations

On 3 July 1979, a dense but very local population of *P. circumcinctus* was found in stands of *B. cernua* on the edge of a small pond (Bull Pasture Pond,

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Cornell University Golf Course). Both nymphs and adults of the predator were feeding on larvae and adults of *Calligrapha californica coreopsivora* Brown (Coleoptera: Chrysomelidae). Voucher specimens of both predator and prey have been placed in the Cornell University Insect Collection under Lot 1086. The age structure of the *P. circumcinctus* population on *B. cernua* was very similar to that of populations of the predator on or about the same date in stands of goldenrod (Evans 1982a): fourth- and fifth-instar nymphs and adults predominated, although younger nymphs (including a group of newly hatched first-instar nymphs) were also present. Several clusters of hatched eggs of *P. circumcinctus* were found on the vegetation. Relatively few late-instars of larvae of the beetle were present but adults were common.

Twenty meters distant grew a small (20 × 10 m) but dense stand of goldenrod where nymphs and adults of *P. circumcinctus* also occurred. Adults of *P. circumcinctus* were collected in both habitats. Vernier calipers were used to measure length from the anterior tip of the pronotum to the posterior tip of the abdomen and width across the widest part of the abdomen. Adults of *P. circumcinctus* from goldenrod at Bull Pasture Pond and other localities were of similar size. However, adults from *B. cernua* were unusually small (Tables 1 and 2; $P < .001$ for length and width of both sexes in t test comparisons of adults from *B. cernua* vs. from goldenrods at all sites).

All adults of *P. circumcinctus* were marked and released in both habitats, after measuring them. No marked individuals were recaptured. By mid-July, individuals of *P. circumcinctus* were much less numerous in both habitats and most individuals were adults. No larvae of *C. californica coreopsivora* were found and adults were also much less abundant than formerly. Adult

Table 1. The mean ($\bar{x}$) ± two standard errors (SE), range, and sample size (N), of lengths and widths (mm) of *P. circumcinctus* females captured on comparable dates in early and mid-July in 1979 in stands of *B. cernua* and *Solidago* (BPP: Bull Pasture Pond, Brk: Brooktondale; descriptions of the Brooktondale and Whipple sites appear in Evans 1980).

				Length		Width	
Vegetation	Site	Date	N	$\bar{x}$ ± 2 SE	Range	$\bar{x}$ ± 2 SE	Range
Bidens	BPP	July 3	9	7.9 ± 0.1	7.8–8.1	5.5 ± 0.1	5.4–5.6
Solidago	BPP	July 3	2	8.3 —	8.1–8.5	5.6 —	5.5–5.7
	Brk	July 3	10	8.4 ± 0.1	8.2–8.7	5.8 ± 0.1	5.5–6.0
	Whipple	July 1	22	8.5 ± 0.1	8.2–8.8	5.8 ± 0.1	5.6–6.1
Bidens	BPP	July 18	4	7.9 ± 0.1	7.6–8.2	5.4 ± 0.1	5.3–5.7
Solidago	BPP	July 18	2	8.4 —	8.3–8.4	5.6 —	5.6–5.7
	Brk	July 17	3	8.3 ± 0.1	8.3–8.4	5.8 ± 0.2	5.6–6.0
	Whipple	July 19	11	8.3 ± 0.2	7.5–8.7	5.6 ± 0.1	5.2–5.8

Table 2. The mean ($\bar{x}$) ± two standard errors (SE), range, and sample size (N), of lengths and widths (mm) of *P. circumcinctus* males captured on comparable dates in early and mid-July 1979 in stands of *B. cernua* and *Solidago* (BPP: Bull Pasture Pond; Brk: Brooktondale).

				Length		Width	
Vegetation	Site	Date	N	$\bar{x}$ ± 2 SE	Range	$\bar{x}$ ± 2 SE	Range
Bidens	BPP	July 3	17	7.3 ± 0.1	6.9–7.6	5.1 ± 0.1	4.9–5.4
Solidago	BPP	July 3–4	4	7.7 ± 0.2	7.6–7.9	5.5 ± 0.2	5.3–5.7
	Brk	July 3	13	7.7 ± 0.1	7.4–8.0	5.4 ± 0.1	5.2–5.6
	Whipple	July 1	11	7.6 ± 0.1	7.3–8.2	5.3 ± 0.1	5.0–5.6
Bidens	BPP	July 18	4	7.4 ± 0.1	7.3–7.5	5.1 —	5.1
Solidago	BPP	July 18	3	7.6 ± 0.1	7.5–7.7	5.3 ± 0.1	5.2–5.4
	Brk	July 17	6	7.3 ± 0.2	6.8–8.2	5.1 ± 0.2	5.0–5.6
	Whipple	July 19	11	7.4 ± 0.1	7.2–7.6	5.1 ± 0.1	4.8–5.4

females of the predator from *B. cernua* were still unusually small in comparison to females in goldenrod stands (Table 1; $P < .01$ for length, $P = .10$ for width in t test comparisons). However, adult males did not differ significantly in either length or width in the two kinds of vegetation (Table 2).

On 5 July 1979 I visited a second stand of *B. cernua* at the edge of a small pond several km west of Ithaca. *Calligrapha californica coreopsivora* was very abundant (much more so that at Bull Pasture Pond), but only a few nymphs and two adult males of *P. circumcinctus* were found in an extensive search. Sparse stands of goldenrod grew on hillsides surrounding the pond. In one of these stands, a single *P. circumcinctus* adult male was collected. As at Bull Pasture Pond, this individual was larger (length: 7.5 mm, width: 5.4 mm) than the two males collected from *B. cernua* (7.3 and 7.0 mm in length, 5.0 and 4.8 mm in width, respectively).

Discussion

The predator-prey relationship of *P. circumcinctus* and *C. californica coreopsivora* in stands of *B. cernua* bears strong resemblance to the relationship between the predator and its prey (*Trirhabda*) in stands of goldenrod (Evans 1982a). Both prey have sluggish larvae which briefly occur in great densities in early summer. Nymphs of *P. circumcinctus* easily subdue the sluggish larvae of *Trirhabda* (Evans 1982b). The weak responses of *C. californica coreopsivora* larvae when probed with a pencil suggest that these larvae are also easily captured by stinkbug nymphs. The similarity in age structure of *P. circumcinctus* populations in stands of goldenrod and *B. cernua* in July suggests that the predator's timing of reproduction is similar in both habitats. Thus the development of *P. circumcinctus* nymphs apparently is well synchronized with availability of *C. californica coreopsivora* larvae as prey in stands of *B. cernua* in fashion similar to patterns of predator and prey observed in goldenrod stands (Evans 1982a).

The major difference between individuals of the predator in the two habitats is the difference in body size of newly molted adults. The rate that nymphs consume prey has a dramatic effect on subsequent adult size in *P. circumcinctus* (Evans 1980). Thus the striking difference in body size of adults maturing at the same time in adjacent stands of *Solidago* and *B. cernua* suggests that the food supply differed in these two habitats. In particular *P. circumcinctus* nymphs may have experienced greater difficulty in seeking out prey on *B. cernua* than on *Solidago*. Stands of *B. cernua* were less dense than *Solidago* stands, and individual plants touched each other less frequently in *B. cernua* than in *Solidago* stands. Many plants of *B. cernua* were isolated even more because they grew in shallow water. These attributes of *B. cernua* presumably hampered the searching abilities of *P. circumcinctus*; hence *C. californica coreopsivora* was probably protected from the predators by a "moat effect" (Eickwort 1977). In goldenrod stands, predators travelled readily from plant to plant and hence larvae of *Trirhabda* received little protection (Evans 1982b). Further study of the hunting habits of *P. circumcinctus* should reveal the degree to which the physical structure of these two habitats influences this predator's ability to exploit its prey.

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BOOK REVIEW

The North American Grasshoppers. Vol. I. Acrididae: Gomphocerinae and Acridinae. By Daniel Otte. Harvard University Press. 275 p. 1981. $45.

All known species of the slant-faced grasshoppers of North America, including the Caribbean Islands, are illustrated by detailed drawings and 16 full color plates prepared by the author. Keys for genera and species, distribution maps, habitat preferences, as well as grasshopper ecology, behavior and life cycles are discussed in detail. Taxonomic changes made in this volume are included in Appendix I. Genera and species of Gomphocerinae and Acridinae are in Appendices II and III. A glossary of terms and a taxonomic index complete the volume. The book is carefully written, the format of the volume is excellent and typographical errors are rare. The author, Associate Curator of Entomology at the Academy of Natural Sciences in Philadelphia has provided a valuable contribution to the taxonomy of grasshoppers and a definitive reference that will be especially appreciated by all who are interested in these grazing herbivores and pests, as well as by taxonomists, ecologists, and economic entomologists. The forthcoming volumes II and III will comprise the Oedipodinae, Melanoplinae, Romaleinae and other smaller groups.

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